CONSTRAINTS ON THE SIZE OF THE VREDEFORT IMPACT CRATER FROM NUMERICAL MODELING. E. P. Turtle and E. Pierazzo, Lunar and Planetary Lab., University of Arizona, Tucson, AZ 85721-0092.

Today the Vredefort structure in South Africa's Witwatersrand Basin consists of a central granite core surrounded by a ~15km wide collar of upturned sedimentary and volcanic deposits. Based on the occurrences of shock features and the discovery of a small meteoritic component in the Vredefort granophyre [1] the structure is generally believed to be the eroded remnant of a 2Ga old impact crater.

Recently, Therriault et al. [2] used the observed distribution of shock features around the Vredefort structure to estimate the diameter of the transient crater. Planar deformation features (PDF's) are observed out to a distance of 38km from the center of the structure [3], while shatter cones are found between 51 and 62km from the center [2]. The relationship between the location of these features and the size of the transient crater in other impact structures led Therriault et al. to estimate that the transient crater at Vredefort was 136-152km in diameter. Using various scaling relations they calculated a final crater diameter of 270-300km.

We have approached the problem from a different perspective. According to [3] the PDF's at Vredefort were formed by shock pressures greater than 6 GPa, while shatter cones form at pressures between 2 and 6 GPa [4]. Using computer modeling we can calculate shock pressure contours in the target for impact events of various magnitudes. These contours can then be used to delineate regions where various shock features are created by the impact event. A comparison of the modeled locations of the shock features with the observed locations allows us to constrain the size of the transient crater.

The impact simulations were carried out using Sandia's 2-D finite difference hydrocode CSQIII coupled with the semianalytical equation of state, ANEOS. Our target consisted of 14km of quartzite, representing the sedimentary layers, over a 31.5km layer of granite, representing the continental crust, below which is a dunite mantle. This roughly approximates the pre-impact stratigraphy at Vredefort [5] while using materials for which equations of state have been developed. To delineate shock pressure contours one hundred massless tracer particles, which record the condition of material at local positions, have been regularly distributed in the target. We have carried out impact simulations for projectiles 14 and 17km in diameter at an impact velocity of 20km/s, that, according to the Schmidt-Holsapple scaling relation, would produce transient crater diameters of 125 and 150km respectively. To account for the displacement of the rocks following the formation of the transient crater we applied Maxwell's Z-model [6] to the simulation results.

The substantial displacement that occurs during collapse of the transient crater was modeled using the finite-element code Tekton. Unfortunately, the current version of the program does not include inertia, so these results must be considered approximate. We created meshes for each transient crater size. To determine the amount by which the shock contours were displaced we found the nodes which were closest to the locations of the shock contours and followed them through the crater collapse.

Figures 1 and 2 show our results for the 14 and 17km diameter projectiles (corresponding to transient craters 125 and 150km in diameter, respectively). These results favor the smaller transient crater. In figure 1 the post-collapse 2GPa and 6GPa shock contours fall within the range of observed shatter cones, whereas in figure 2, the upper limit of shatter cone formation falls well outside of region in which they are observed.

REFERENCES: [1] Koeberl, C. *et al*. (1996) submitted to *Geology*. [2] Therriault, A.M., *et al.* (1996) submitted to *Meteoritics*. [3] Grieve, R.A.F., *et al.* (1990) *Tectonophysics*, **171**, pp. 185-200. [4] Roddy, D.J. and Davis, L.K. (1977) in *Impact and Explosion Cratering*, Roddy, D.J., *et al.*, (Eds.) pp. 715-750. [5] Reimold, W.U., pers. comm. [6] Maxwell, D.E. (1977) in *Impact and Explosion Cratering*, Roddy, D.J., *et al.* (Eds.), pp. 1003-1008.

Figure 1: Results for the case of a 125km diameter transient crater. The triangles represent the 2Gpa shock contour after the opening of the transient crater (open triangles) and after its collapse (filled triangles). The squares represent the 5GPa shock contour before collapse (open squares) and after collapse (filled squares). The dashed horizontal line represents the present surface after 6km of erosion [2]. The solid vertical line shows the radial extent of PDF's and the two vertical dotted lines show the range within which shatter cones are found. The bold line illustrates the post-collapse surface (the sharp rise is the unrelaxed rim of the transient crater).

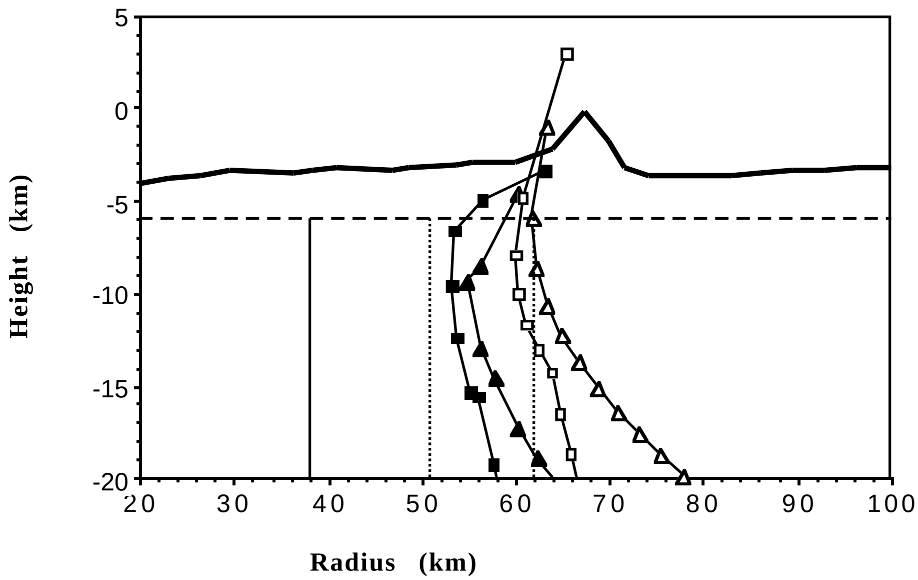

Figure 2: Results for the case of a 150km diameter transient crater. The symbols used are described in the caption for figure 1: triangles representing the 2GPa contours and squares the 6GPa contours.